

R E M A R K S

Information Disclosure Statement

The Examiner is respectfully requested to return to the undersigned a copy of each of the IDS Forms filed on December 11, 2008 and May 28, 2008, with the Examiner's initials in the left column next to each cited publication to indicate that each cited publication was considered and made of record.

Presently Claimed Invention

The presently claimed invention pertains to a rolling element which is made from a steel, the steel comprising 0.5 to 1.5 wt% carbon; 0.3 to 1.5 wt% Cr; and a total amount of 0.2 to 2.0 wt% of one or more alloy elements selected from the group consisting of V, Ti, Zr, Nb, Ta and Hf; wherein 0.4 to 4.0 % by volume of carbides of said alloy elements having an average particle diameter of 0.2 to 5  $\mu$ m are dispersed,

wherein the rolling element has a rolling contact surface layer, the rolling contact surface layer has a quench hardened layer which has been subjected to induction hardening, the quench hardened layer has a martensite parent phase and the martensite parent phase has a soluble carbon concentration of 0.3 to 0.8 wt%, and

said carbides in an amount of 0.4 to 4.0% by volume and cementite in an amount of 2 to 15% by volume are dispersed within the martensite parent phase (see applicant's claim 1).

The presently claimed invention also relates to a method of producing a rolling element from a steel,

the steel comprising 0.5 to 1.5 wt% carbon; 0.3 to 1.5 wt% Cr; and a total amount of 0.2 to 2.0 wt% of one or more alloy elements selected from the group consisting of V, Ti, Zr, Nb, Ta and Hf, wherein 0.4 to 4.0 % by volume of carbides of said alloy elements, and having an average particle diameter of 0.2 to 5  $\mu\text{m}$  and 7.5 to 20 % by volume of cementite are dispersed,

the method comprising subjecting said steel to induction hardening by heating and quenching,

wherein the rolling element has a rolling contact surface layer, the rolling contact surface layer has a quench hardened layer which has been subjected to induction hardening, the quench hardened layer has a martensite parent phase and the martensite parent phase has a soluble carbon concentration of 0.3 to 0.8 wt% and

wherein 0.4 to 4.0% by volume of said carbides and 2 to 15% by volume of cementite are dispersed within the martensite parent phase (see applicant's claim 20).

#### Obviousness Rejection

Claims 1 to 12, 20 to 23 and 25 to 27 were rejected under 35 USC 103 as being unpatentable over EP 950 723 for the reasons set forth in the previous Office Actions dated June 19, 2007, December 18, 2007 and June 5, 2008 (see item no. 3 on page 2 of the August 20, 2008 Office Action).

It was admitted in the previous Office Action of June 19, 2007 that a Cr concentration of 2.5 to 10 wt% in the cementite

((FeCr)<sub>3</sub>C), as recited in claim 1, is not taught by the prior art.

It was admitted in the December 18, 2007 Office Action that the prior art does not teach prior austenite grains having an ASTM grain size No. 10 as recited in applicant's claim 3.

It was further admitted in the December 18, 2007 Office Action that EP 950723 does not teach induction heating and heating at 150°C/sec or more, as recited in applicant's claims.

It was also admitted in the December 18, 2007 Office Action that EP 950723 does not teach a soluble carbon concentration of 0.3 to 8 wt% in the martensite of the quench hardened layer as recited in applicant's claims.

#### Rebuttal of the Obviousness Rejection

EP 950723 has the following characteristics 1 to 4 (see paragraphs 0016, 0017, 0018, 0020 and 0034 of EP 950723 in particular):

1. A fine nitride and/or fine carbonitride having an average grain size of 0.3  $\mu\text{m}$  or less is essentially dispersed in a contact surface by carburization/carbonitriding or carbonitriding.
2. The volume of the dispersed nitride and/or carbonitride is 1 to 15% by volume (0.5 to 4.5 wt% in the case of AlN, which equates to 1.2 to 10.8% by volume).

3. A steel material containing at least 0.3 to 3.0 wt% Al is used.

4. The contact surface which has been treated by carburization/carbonitriding or carbonitriding contains 0.6 to 3.0 wt% C and 0.4 to 2.5 wt% N.

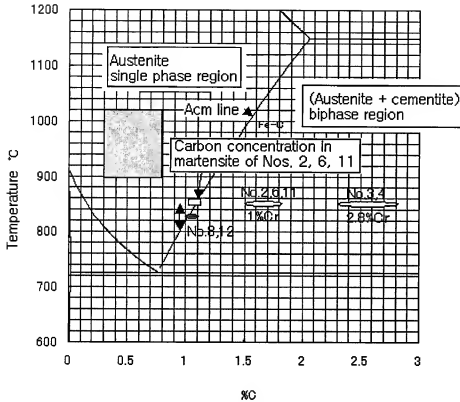
In paragraph 0026 of EP 950723, it is stated that the quantitative control for residual austenite is carried out by controlling carbon potential and nitrogen potential. It is clear that the martensite parent phase of the surface layer of Alloy No. 11 shown in Fig. 9 contains nitrogen at high concentrations.

In paragraph 0034 of EP 950723, it is stated that cementite precipitation increases as the carbon content increases after the carbon content exceeds 1.1 wt%. From this it is clear that the martensite carbon concentration is about 1.1 wt% in a structure of the martensite parent phase in which cementite is dispersed. Further, when comparing the embodiments of Figs. 3, 4 and 5 of EP 950723, it is understood that the carbon potential ( $C_p$ ) is adjusted to 1.1 or more in the case of dispersing cementite by carburization/carbonitriding. Accordingly, it is clear that the carbon concentration in the martensite parent phase is 1.0 wt% or more (Fig. 3 of EP 950723).

As another characteristic of EP 950723, paragraph 0043 states the steel is reheated to the  $A_1$ -point temperature to 900°C, and while cementite is precipitated or dispersed, a

carburization/carbonitriding or a carbonitriding treatment is performed in order to prevent aggregation or coarsening of the cementite and to adjust its average grain size so as to be 0.3  $\mu\text{m}$  or less (see paragraph 0031 of EP 950723). Paragraph 0031 of EP 950723 states that the temperature at which nitrogen is permeated is preferably 800 to 850°C to ensure the quenching characteristics of the steel. It is clear that when dispersing cementite in the surface layer, the carbon concentration in the surface layer should be controlled under such conditions that are within the biphasic region (austenite + cementite) in the Fe-C system phase diagram of HANSEN, and it is well known to obtain the carbon concentration in austenite from the Ac<sub>m</sub> line between 800 to 850°C. The obtained carbon concentration is 0.95 to 1.07 wt%. Therefore, the carbon concentration in the martensite parent phase in the surface layer in which cementite particles are dispersed is also 0.95 to 1.07 wt%.

A graph of the Fe-C system phase diagram of HANSEN which shows the surface carbon concentrations of Nos. 2, 6, 11, 8 and 12 of EP 950723 in which cementite is precipitately dispersed is reproduced as follows:



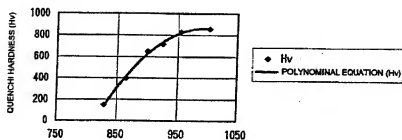
In EP 950723, the carbon concentrations in the carburized layers of Nos. 2, 6 and 11 in which cementite is precipitately dispersed in the carburized layers ranges between 1.5 to 1.8 wt%. The carbon concentration in the martensite parent phase of the carburized layer and the carbon concentration of the martensite parent phases of Nos. 8 and 11 (standard bearing steel) which have been carbonitrided are between 1.0 to 1.1 wt% based on the relationship of the Fe-C system equilibrium diagram.

In contrast to EP 950723, the carbon concentration of the martensite parent phase in which cementite is dispersed according to the presently claimed invention is controlled such that Cr concentration in the cementite is adjusted to 2.5 to 10 wt%, and as shown clearly in Fig. 14 of the present application, the quenching temperature is controlled by a high-frequency induction heating method. The high-frequency induction heating temperature range which controls the carbon concentration range to 0.3 to 0.8 wt% in the martensite parent phase is shown in Fig. 14 in the present application.

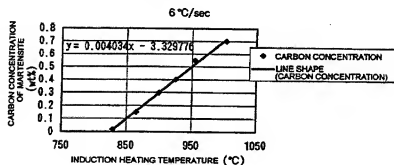
According to EP 950723, in order to prevent aggregation or coarsening of the cementite (3  $\mu\text{m}$  or less) to be precipitately dispersed, a dispersion treatment thereof is performed at a temperature of 900°C or less. In contrast thereto, in the presently claimed invention, the quench-heating temperature is adjusted to be 900°C or higher (see applicant's claim 22) as shown in Fig. 14 in the present application, and the partial solid dissolving of the cementite into austenite is controlled.

Fig. 14 in the present application is reproduced as follows:

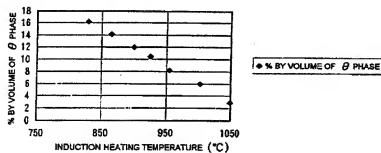
FIG. 14



14 (a)



14 (b)



14 (c)



Further, according to EP 950723, if the steel is once cooled after carburizing, and then reheated in the biphasic region (austenite + cementite), cementite in the form of pearlite formed during the cooling process is also granulated. This granulated cementite agglutinates or becomes a coarsening cementite. In the presently claimed invention, because of an immediate heating means by a high-frequency wave, the structure before quenching becomes a pearlite structure (see the hardened structure in Fig. 17 of the present application), whereby causing cementite dispersed in the form of pearlite to remain in the martensite parent phase.

The following was stated in the previous Office Action dated June 19, 2007 on page 3, item 5:

"EP '723 in claims 1 and 5 discloses cementite dispersed in an amount of up to 30 vol%, which overlaps 2 to 15 vol% recited in claim 2. Even though a Cr concentration of 2.5 to 10 wt% in the cementite ((Fe, Cr), C) as recited in claim 1 is not taught by prior art, such would be expected since prior art in paragraph 43 teaches the Cr concentration heat treating step of reheating after hardening at A1 to less than 900°C."

In response to the foregoing assertion in the June 19, 2007 Office Action, it is respectfully submitted that EP 950723 does not teach a Cr concentration heat treating step. EP 950723 discloses only a treatment process wherein carburizing/

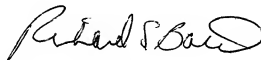
carbonitriding is performed to make cementite contain carbon and nitride.

Withdrawal of the 35 USC 103 rejection is thus respectfully requested.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

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Respectfully submitted,



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Enclosure: PETITION FOR EXTENSION OF TIME